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HEALTH BEHAVIOURS AND BODY MASS INDEX AMONG WOMEN WITH BREAST CANCER

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List of Abbreviations

Background

ASIR	Age-standardised Incidence Rate
ASMR	Age-standardised Mortality Rate
BMI	Body Mass Index
E	European standard population
RORENO	North Region Cancer Registry
UK	United Kingdom
USA	United States of America
W	World standard population
WHEL	Women's Healthy Eating and Living

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AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Interval
METER	Medical Term Recognition Test
MoCA	Montreal Cognitive Assessment

1. Resumo

Introdução: Nas últimas décadas, tem-se observado um aumento da sobrevivência ao cancro da mama, sobretudo devido às tendências para o diagnóstico precoce e ao uso de tratamentos mais efetivos. No entanto, as sobreviventes de cancro da mama experienciam frequentemente efeitos tardios e a longo prazo do cancro e respetivos tratamentos, incluindo o maior risco de segundos cancros primários e outras doenças crónicas. A adoção de comportamentos mais saudáveis e Índice de Massa Corporal (IMC) adequado são essenciais para promover a saúde nas sobreviventes de cancro da mama, e o diagnóstico de cancro pode ser uma oportunidade para a melhoria destes comportamentos.

Objetivos: Com este estudo pretendeu-se analisar as alterações nos comportamentos de saúde e no IMC após o diagnóstico de cancro da mama, descrevendo a possível influência das características sociodemográficas, clínicas e psicológicas, assim como dos níveis de literacia em saúde.

Métodos: Foram incluídas neste estudo 428 participantes que fazem parte de uma coorte prospetiva de mulheres com diagnóstico recente de cancro da mama, admitidas na Clínica da Mama do Instituto Português de Oncologia do Porto, Portugal, durante o ano de 2012, e que participaram na avaliação de seguimento efetuada três anos após o diagnóstico. Nesta reavaliação recolheram-se dados sobre o consumo de tabaco, álcool, frutas e vegetais, prática de atividade física e IMC, relativamente ao período pré e pós-diagnóstico. Para quantificar as associações entre as características das sobreviventes e as mudanças em cada *outcome*, foram calculados os *odds ratio* ajustados (AOR) e respetivos intervalos de confiança (IC 95%), através de regressão logística. Esta análise foi estratificada tendo em conta a adesão às recomendações para prevenção do cancro no período anterior ao diagnóstico.

Resultados: Após o diagnóstico, 54,1% das participantes pararam de praticar atividade física, 32,4% ficaram com excesso de peso ou obesidade, 6,1% reduziram o consumo de frutas e vegetais para menos que cinco porções por dia. Apenas uma mulher aumentou o seu consumo de álcool para mais que uma unidade por dia e nenhuma começou a fumar. Entre as sobreviventes que não cumpriam as recomendações antes do diagnóstico, 29,1% deixaram de fumar, 24,6% diminuíram o consumo de álcool para ≤1 unidade por dia, e 3,3% tinham IMC adequado. Menos de 10% das mulheres aumentou a sua atividade física e consumo de frutas e

vegetais. As mais velhas e com níveis mais elevados de escolaridade foram as que mais frequentemente pararam a prática de atividade física (AOR=4,71, IC 95%: 1,17-18,99; AOR=11,53, IC 95%: 2,20-60,53, respetivamente). As mulheres mais velhas também iniciaram a prática de exercício físico com menor frequência (AOR=0,32, IC 95%: 0,14-0,75).

Conclusão: As mulheres com diagnóstico de cancro da mama reportaram mudanças positivas nos seus comportamentos de saúde após o diagnóstico. No entanto, ainda existe uma ampla margem de intervenção, o que destaca a importância de desenvolver ações de promoção da saúde destinadas especificamente a esta população.

2. Abstract

Background: In the last few decades, the trends towards earlier diagnosis and use of more effective treatments have contributed to an increased survival of breast cancer. Nevertheless, breast cancer survivors often experience late and long-term effects of disease and its treatments, including a higher risk of second primary cancers and other chronic diseases. Therefore, the adoption of healthier behaviours and adequate body mass index (BMI) are essential to promote overall health among breast cancer survivors, and cancer diagnosis may be an opportunity for its improvement.

Objectives: We aimed to analyse changes in health behaviours and BMI among women after breast cancer diagnosis, depicting the potential influence of socio-demographic characteristics, clinical and psychological features, and health literacy.

Methods: In this study, we included 428 participants who were enrolled in a prospective cohort of women with newly diagnosed breast cancer, admitted to the Breast Clinic of the Portuguese Institute of Oncology of Porto, Portugal, during 2012, and who were evaluated three years after diagnosis. In this follow-up evaluation, data regarding smoking, alcohol consumption, physical activity, fruit and/or vegetables intake, and BMI, either pre- or post-diagnosis, were collected. To quantify associations between patients' characteristics and changes in each outcome, adjusted odds ratio (AOR) and respective 95% confidence intervals (95% CI) were calculated using logistic regression. This analysis was stratified according to the participants' adherence to cancer prevention recommendations before diagnosis.

Results: After diagnosis, 54.1% of participants ceased the practice of physical activity, 32.4% became overweight/obese, and 6.1% reduced fruits and/vegetables intake to <5 portions/day. Only one women increased her alcohol consumption to more than one unit per day and none started to smoke. Among patients who did not meet recommendations pre-diagnosis, 29.1% stopped smoking, 24.6% diminished alcohol consumption to ≤ 1unit/day, and 3.3% had normal BMI. Less than 10% of women incremented their physical activity and fruit and/or vegetables intake. Older and higher educated participants were more likely to cease physical activity (AOR=4.71, 95% CI: 1.17-18.99; AOR=11.53, 95% CI: 2.20-60.53, respectively). Older women had also less odds to start this behaviour after diagnosis (AOR=0.32, 95% CI: 0.14-0.75).

Conclusions: Although breast cancer patients reported some positive changes in health behaviours after diagnosis, there is still a large margin for improvement, which highlights the importance of outline health promotion interventions, specifically addressed to this population.

3. Background

3.1 Trends in breast cancer incidence, survival and mortality

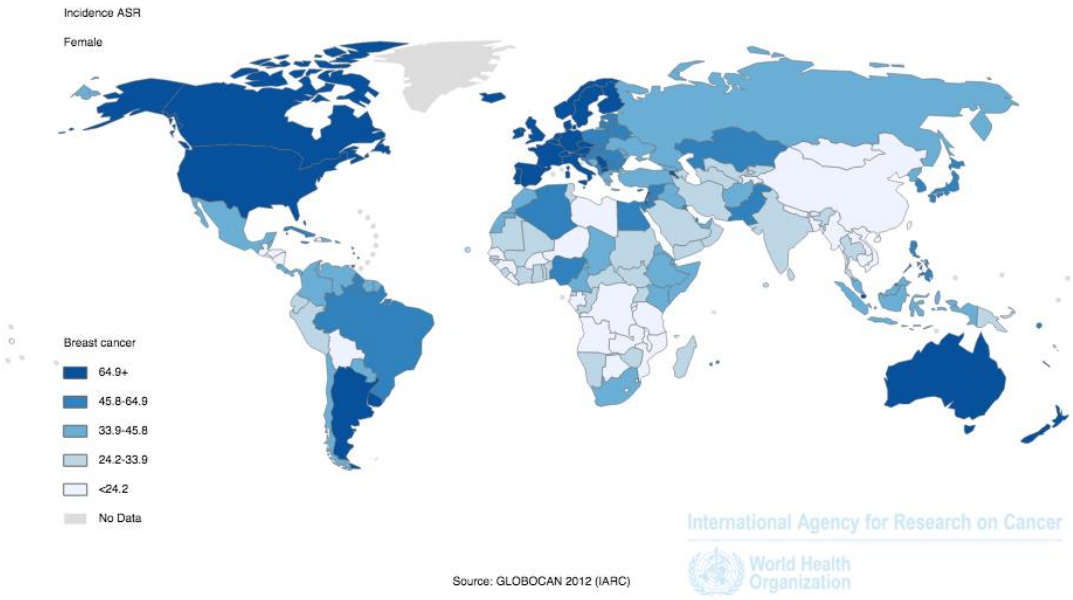
3.1.1 Incidence

3.1.1.1 Worldwide

Breast cancer is the most common cancer among women worldwide and it is estimated that, in 2012, 1.7 million new cases were diagnosed, which represents 12% of all new cancer cases and 25% of all cancer in women (Figure 1) (1). In the same year, the highest age-standardized incidence rate (ASIR), world standard population (W), of breast cancer was in Western Europe (96.0/100 000), Northern America (91.6/100 000) and Northern Europe (89.4/100 000) and the lowest incidence in Middle Africa (26.8/100 000), Eastern Asia (27.0/100 000) and South-Central Asia (28.2/100 000) (1).

Globally, breast cancer incidence has been increasing over the years in historically lower-risk areas, such as Latin America, Africa and Asia, due to longer life expectancy, delayed childbearing and/or having fewer children, menopausal hormone use, the rising prevalence of obesity, as well as increased detection through (2). However, it has decreased in last decade in countries like United States of America (USA) (3, 4), Canada, Australia, United Kingdom (UK) and France (5) and it has been stable in the past years, mostly due to increase in breast cancer screening and lower use of postmenopausal combined hormone therapy (6-8).

Figure 1. Worldwide distribution of estimated age-standardized breast cancer incidence (per 100 000) in 2012.

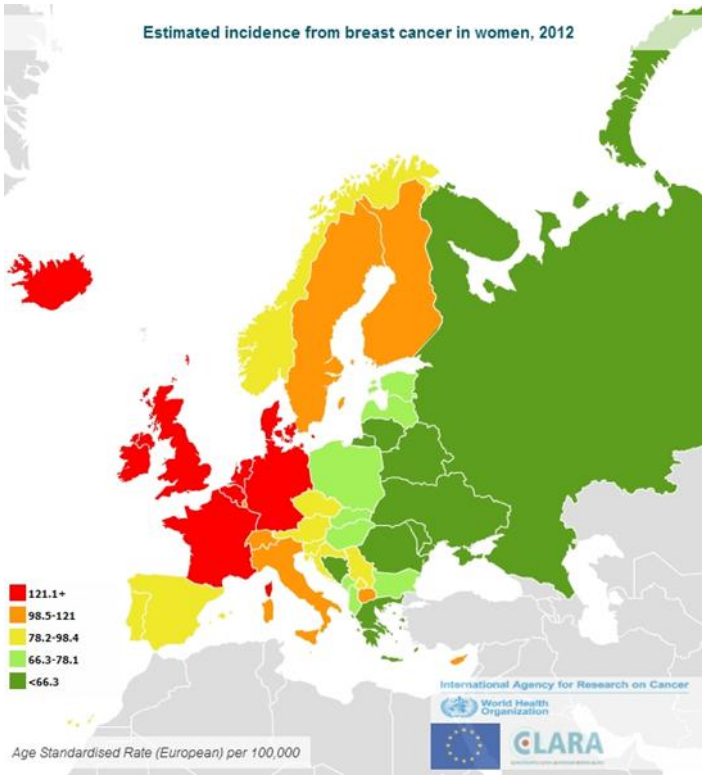


Source: GLOBOCAN, 2012 (1).

3.1.1.2 Europe

In Europe, the estimated proportion of the total number of cancer cases was 28.8% due to breast cancer, which represents the most frequent cancer in women (9); the estimated ASIR, European standard population (E), of breast cancer among women was 92.8/100 000 in 2012 (9). In that year, the ASIR (E) was higher in Belgium (147.5/100 000), followed by Denmark (142.8/100 000) and France (136.6/100 000). The lowest estimated ASIR (E) was observed in Bosnia Herzegovina (49.1/100 000), Moldova (52.9/100 000) and Ukraine (54.0/100 000) (Figure 2) (9).

Figure 2. Europe distribution of estimated age-standardized breast cancer incidence (per 100 000) in 2012.

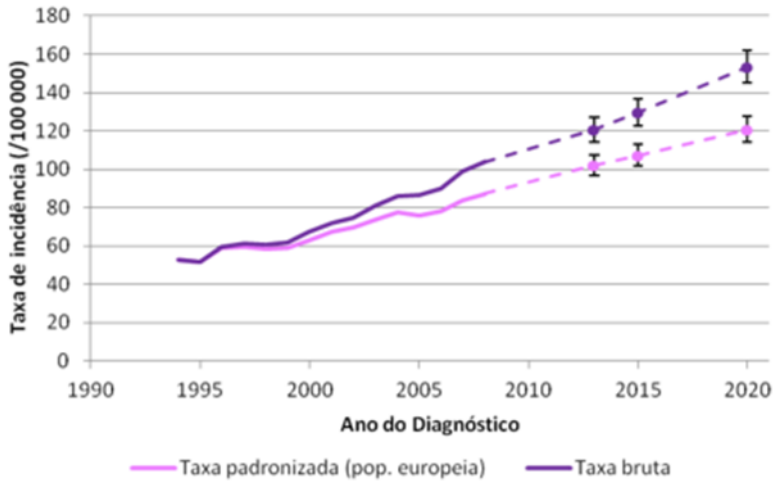


Source: EUCAN, 2012 (9).

3.1.1.3 Portugal

In Portugal, the most recent data revealed an ASIR (E) of 93.2/100 000 in women in 2010 (10). Specifically in Northern Portugal, the estimated ASIR (E) was 93.9/100 000 (11), and it is expected that this number continues to increase in the next years (Figure 3) (12).

Figure 3. Incidence trends and predictions for North Portugal.



Source: North Region Cancer Registry (RORENO), 2014 (12).

3.1.2 Survival

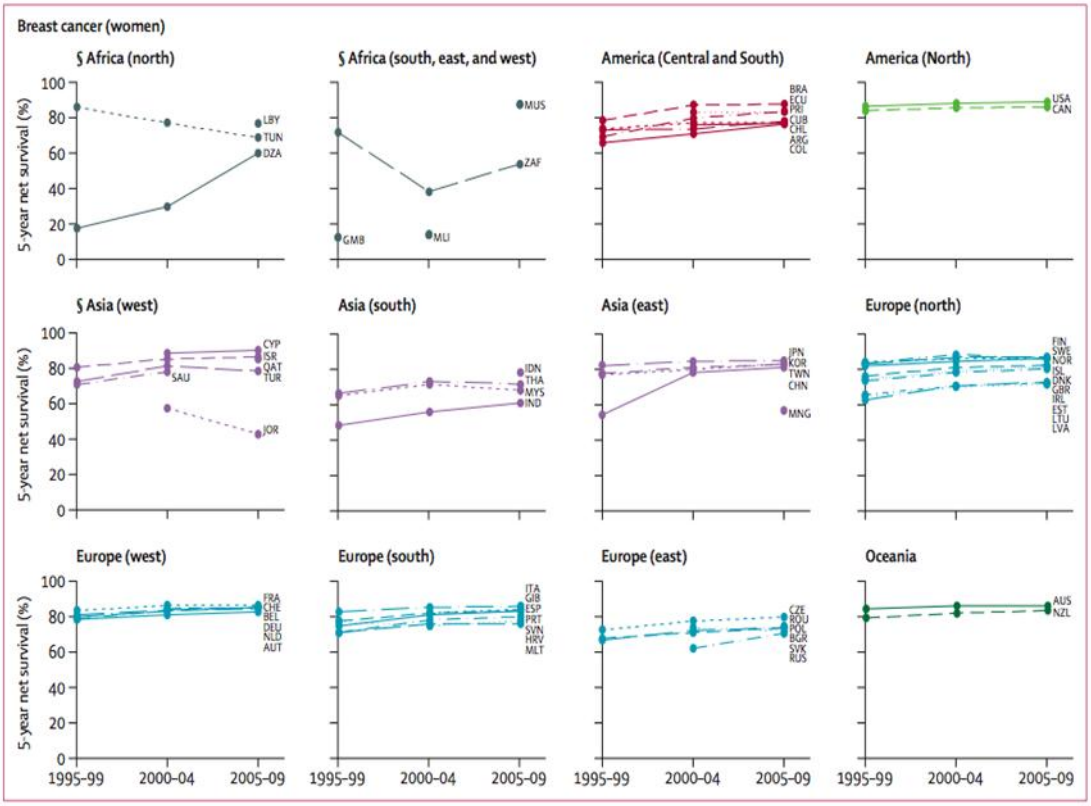
3.1.2.1 Worldwide

The increasing number of new cases of breast cancer observed in the last few years, along with the intense activities for early detection and the access to more effective treatments, have contributed to the increasing number of breast cancer survivors (13). Worldwide, in 2012, there were an estimated 6.2 million breast survivors alive five years after diagnosis (1), with the highest proportion from Northern America and the lowest from African and Asian countries.

According to the data available from the CONCORD-2 Study, the age-standardized five-year net survival of breast cancer was 80% or higher in 34 countries all over the world, including Cyprus (90.6%), USA (88.6%) and Brazil (87.4%), being lower than 65% in South Africa (53.4%), Mongolia (56.5%) and India (60.4%). Between 1995-1999 and 2005-2009, breast cancer survival increased in countries like Central and South America, particularly in Brazil (from 78% to 87%), Colombia (from 66% to 76%), and Ecuador (from 69% to 83%). Likewise, in North America and Oceania breast cancer survival was high with range between 84-89% and with stable or slightly improving in survival in the period of 2005-2009. In Europe, survival increased as well, although it was lower than North America and Oceania, and had wider geographic range (13). Moreover, in Algeria

survival also increased (from 17% to 60%) but this trend is less reliable and survival trends of several African countries were not available (Figure 4) (13).

Figure 4. Trends in age-standardized 5-year net survival for women diagnosed with breast cancer during 1995–99, 2000–04, and 2005–09, by continent or region and country.



Source: Allemani et al., 2015 (13).

Differences in tumour stage at diagnosis may be one important factor for the observed geographical differences. In fact, the five-year survival is lower among women with cancer in a more advanced stage, namely 99% for localized disease, 84% for regional disease and 24% for distant-stage disease (5, 14-16). In the UK, USA, Canada, Denmark and China more than three-quarters of breast cancers are diagnosed at an early stage (I or II) (5). In contrast, in several developing countries (*e.g.* Nigeria, Libya and Malaysia), the breast cancer is diagnosed at a later stage (III or IV) (5). Some explanations for late-stage diagnosis include lack of awareness, limited access to adequate detection and diagnostic services, social barriers (such as reluctance or refusal to have one's breast

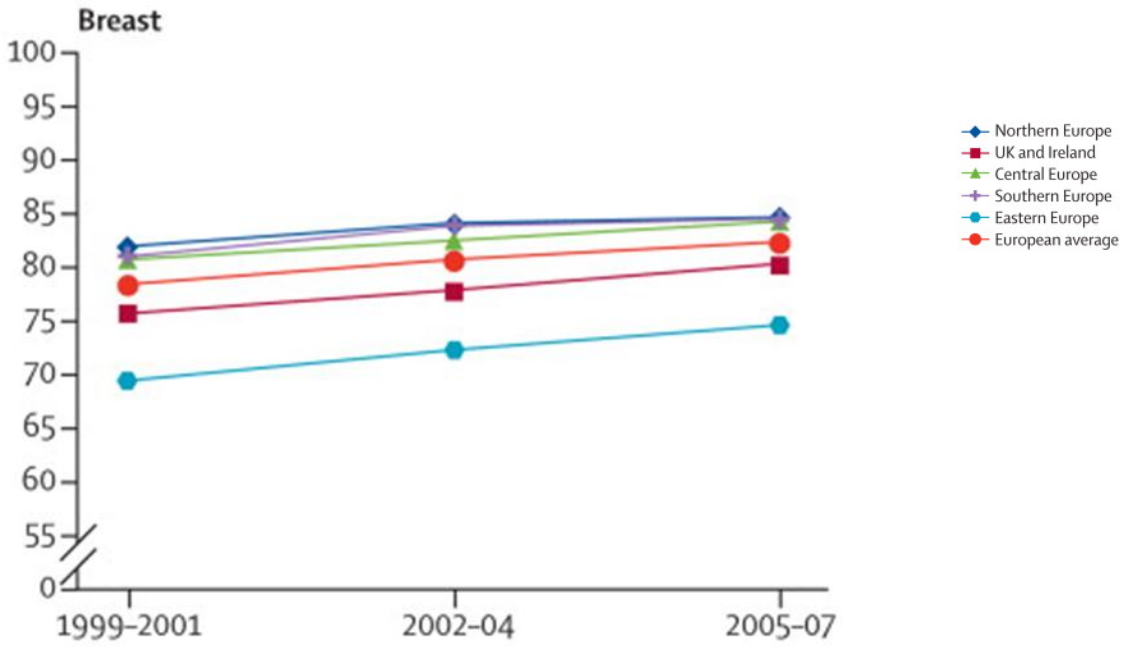
examined by a male doctor), stigma linked to breast cancer and its treatment, and also the belief that cancer is fatal and cannot be changed through individual action (5).

In addition to stage, tumour grade, hormone receptor status and human epidermal growth factor receptor 2 status influence survival (16). Moreover, the tumour size at diagnosis is predictive of the survival; in other words, larger tumour size is associated with decrease survival (14, 16). Likewise, 5-year relative survival rate is lower among women with less than age 40 at the diagnosis (85%), compared with those at 40 years old or older (90%), maybe because the higher aggressiveness of the tumour and/or lower responsiveness to treatment (14, 16). Data from the USA also revealed that survival is lower for black than white women at every stage of diagnosis: for all stages combined, the 5-year relative survival rate is 90% for white women and 79% for black women (14, 16). The reasons for these differences are complex, but can be due to socioeconomic factors, less access and utilization of quality medical care and biological differences in cancers (16).

3.1.2.2 Europe

In Europe, and according to the EUROCARE study, in the last few years, it was observed an increment in breast cancer survival: from 1999-2001 to 2005-2007 it increased from 78.4% to 82.4%. Across Europe, the mean age-standardized five-year relative survival was 81.8% for breast cancer in women, and most of the countries were close to the European mean (Figure 5) (17).

Figure 5. Age-standardized 5-year relative survival for adult breast cancer women followed-up in 1999–2001, 2002–04 and 2005–07.



Source: De Angelis et al., 2014 (17).

The estimated 5-year age-standardised relative survival was highest in Iceland (87.2%), followed by France (86.1%) and by Sweden (86.0%); the lowest were observed in Lithuania (66.7%), Latvia (69.3%) and Poland (71.6%) (17).

Considering the specific-age, breast cancer survival was greater in women between 45 and 54 years and it decrease with age. In women aged 75 years and older, survival was particularly low in the UK and Ireland, accounting for most of the survival difference between these countries and the European mean (17).

3.1.2.3 Portugal

According to the EUROCARE study, in Portugal, the 5-year age-standardized relative survival for patients with breast cancer, diagnosed during 2000-2007, was 83.3%, although in this estimate it was only included part of national population covered by cancer registration (17).

In the Northern region of the country, and taking into account data from the North Region Cancer Registry (RORENO), between 2007 and 2008, the observed 5-year survival rate was 83.6% and the net survival rate was 89.4% (18). In table 1 is presented the evolution of breast cancer survival and it is notable the progress in survival all over the years (18, 19).

Table 1. Evolution in breast cancer survival in women, in the first, third and five-year, between 2005 and 2008, in the North Region.

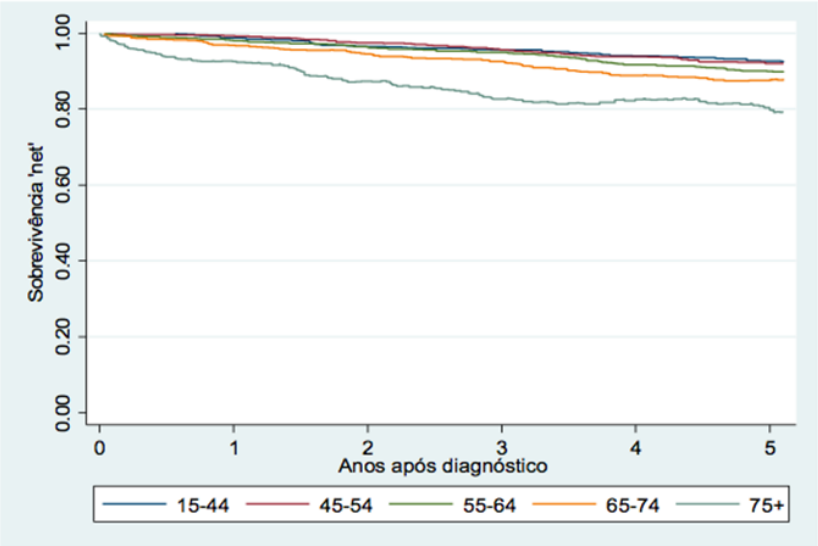
		Breast cancer survival		
		1 year	3 years	5 years
2005-2006	SO	**95.5**	**87.1**	**80.6**
	(95% CI)	(94.7-96.2)	(85.8-88.2)	(79.1-82.0)
	SN	**96.8**	**91.0**	**86.9**
	(95% CI)	(96.0-97.5)	(89.6-92.2)	(85.3-88.4)
2007-2008	SO	**96.2**	**89.6**	**83.4**
	(95% CI)	(95.5-96.8)	(88.5-90.5)	(82.1-84.6)
	SN	**97.4**	**92.9**	**89.1**
	(95% CI)	(96.8-98.1)	(91.8-94.0)	(87.7-90.5)

CI: confidence interval; SO: observed survival; SN: net survival.

Source: RORENO, 2013 (19) and 2014 (18).

Moreover, it was also observable an inverse relationship between net survival and age, i.e., the older women have lower survival, except the women aged 45-54, that in the first-year have the highest net survival rate (Figure 6) (18).

Figure 6. Breast cancer net survival rate in women of North Region, according to age, in 2007-2008.



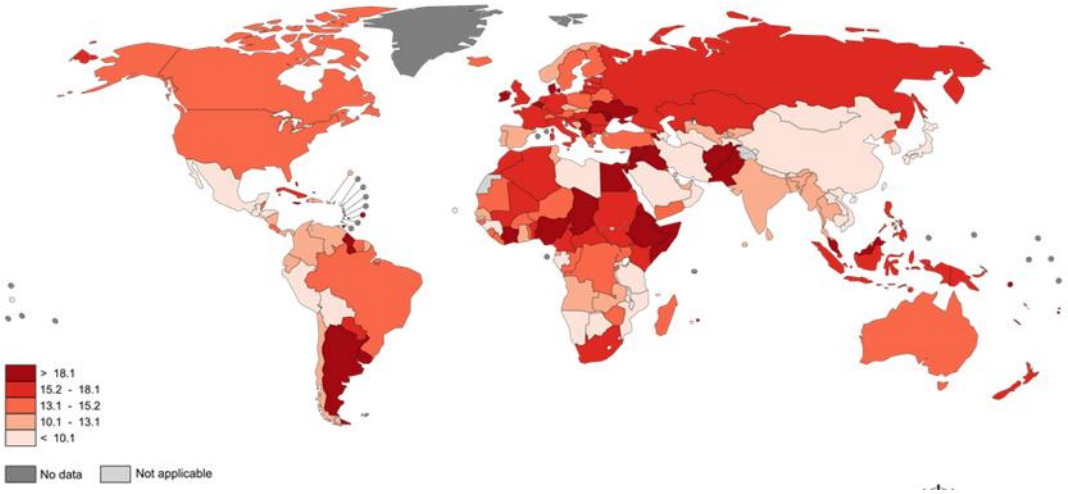
Source: RORENO, 2014 (18).

3.1.3 Mortality

3.1.3.1 Worldwide

Overall, breast cancer was the fifth cause of death (521 800 deaths, 6.4%) in 2012, and it was the most frequent cause of cancer death in women in less developed countries (324 300 deaths, which represents 14.3% of total deaths), and it was the second cause of cancer death in more developed countries (197 500 deaths, which represents 15.4% of the total), after lung cancer (1). The range in age-standardized mortality rates (ASMR), between world regions is less than that for incidence because of the more favourable survival of breast cancer in developed countries, with rates ranging from 6.0/100 000 in Eastern Asia to 20.0/100 000 in Western Africa. The estimated ASMR (W) was highest in Western Africa (20.1/100 000), followed by Melanesia (19.8/100 000) and Northern Africa (17.4/100 000). The lowest estimated ASMR (W) was visible in Eastern Asia (6.2/100 000), Central America (9.5/100 000) and Micronesia/Polynesia (13.1/100 000) (Figure 7) (1).

Figure 7. Worldwide distribution of estimated age-standardized breast cancer mortality (per 100 000) in 2012.



Source: GLOBOCAN, 2012 (1).

Although for many years there was a relatively slow increase in breast cancer death rates (0.4% from 1975 to 1990), from 1990 to 2010 mortality decreased by a mean of 34% in the USA, Canada and many European countries (20). This decline was more pronounced among women younger than 50 years, when compared with those with 50 or more years of age (3.1% versus 1.9% per year). These trends are associated with improvements in the proportion of cases with early detection and breast cancer treatment (21), although the respective contributions of each may vary depending on the level of participation in regular screening and availability of state-of-the-art treatment (22).

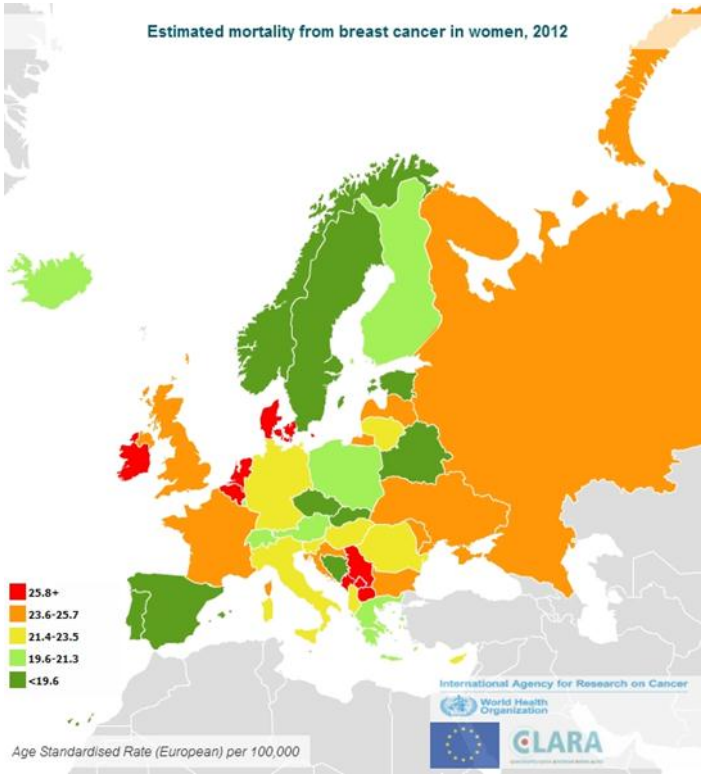
Nonetheless, in some less developed regions, breast cancer is the leading cause of cancer death among women and mortality rates are continuously increasing, due to an increasing on incidence and, in some cases, limited access to treatment (1).

3.1.3.2 Europe

Among European countries, in 2012, breast cancer was the leading cause of death in women (16.8% of the total number of deaths). The estimated ASMR (E), in the same period, was 23.2/100 000, being particularly higher in Macedonia (36.3/100 000), Serbia (31.5/100 000) and Belgium (29.5/100 000). The lowest estimated ASMR (E) was

observed in Estonia (15.1/100 000), Spain (16.7/100 000) and Bosnia Herzegovina (16.9/100 000) (Figure 8) (9).

Figure 8. Europe distribution of estimated age-standardized breast cancer mortality (per 100 000) in 2012.



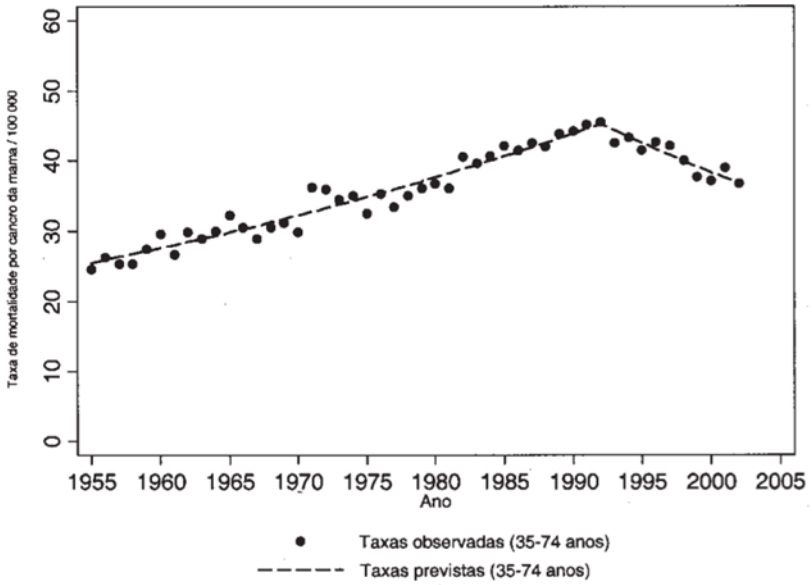
Source: EUCAN, 2012 (9).

Between 1980 and 2010, there was a stable or slightly increasing in ASMR (E) in the first half of the period, and then there was a visible decline, mostly in high-income countries from Western and Northern Europe (23). In the same period, there were countries, especially from Eastern and Northern Europe with the lowest median ASMR (E) at the 1980's that increased their ASMR (E) during the first period and decreased mainly after 1999. The decline in ASMR (E) in this period can be explained by an increase in screening programs and a better access to treatments, which were initiated before 1995 in some countries of Northern, Southern, Western and Eastern Europe (23).

3.1.3.3 Portugal

In Portugal, breast cancer ASMR (E) declined two percent per year between 1992 and 2002 in several regions (Figure 9) and this decline was more marked in the districts that had larger incidence rates, like Lisbon, *Viseu* and *Faro*, respectively (24). Most recent data revealed that, in 2014, the ASMR (E) was 17.9 deaths per 100 000 (10).

Figure 9: Evolution of breast cancer mortality rate (age-standardized, European population) in women aged 35-74 years old, between 1955 and 2002.



Source: Bastos *et al.,* 2007 (24).

The ASMR (E) in Northern Portugal was 15.5/100 000 in all ages, and 9.3/100 000 in women aged less than 65 years old, in 2014 (10).

3.2 Lifestyles among breast cancer survivors

In the past decades there has been an increasing number of breast cancer survivors, due to improvements towards early detection, curative therapies, increment of life expectancy and ageing (25). Nevertheless, breast cancer survivors have an increased risk of recurrence, late effects of treatments, mortality due to non-cancer causes, and they are more likely to develop second primary cancers and a variety of symptoms, that can adversely affect quality of life (26-29). Furthermore, breast cancer survivors are at increased risk for chronic diseases, such as cardiovascular disease, diabetes, and osteoporosis (26, 30).

Despite these negative outcomes may be the result of disease and its treatments, lifestyles also play a role (31, 32). Although a cancer diagnosis has been referred as a teachable moment, where survivors are motivated to make lifestyle changes to improve health outcomes (33, 34), recent studies found that few cancer survivors are actually meeting recommendations (35-39).

These findings emphasize the important role of health promotion actions in enhancing the adherence to healthier behaviours and BMI, among breast cancer survivors.

3.2.1 Smoking

Previous studies have shown that smoking is associated with poor prognosis among breast cancer survivors (40, 41). For instance, compared with never smokers, current smokers have greater risk of breast cancer specific mortality (40-44), recurrence (40), more and larger lymph node metastases (45) and higher risk of all-cause mortality (40, 43, 46). Some studies also suggested that smoking may reduce the effectiveness of cancer therapies (47), and has been associated with more surgical complications (48), as well as with an increased risk of developing a second primary cancer (49). Additionally, smoking habits may be associated with lower levels of quality of life (50). In fact, compared with non-smokers, persistent smokers had higher likelihood of reporting poor physical functioning, mental health, and role emotional (50). Moreover, those who persist smoking report higher levels of usual pain, compared to non-smokers or former smokers, especially those who are younger, have lower perceived health status and some cancer symptoms (51).

Considering these facts, smoking cessation is one of the recommended strategies for health promotion among cancer survivors (33). However, between 10% and 23% continue to smoke after diagnosis (35-37, 39, 52-57). Results from several studies also reveal that cancer survivors quit smoking after their cancer diagnosis, in a percentage between 34% and 46% (39, 52, 55, 58). This lack of engagement in health behaviours has been explained by several factors, including the distress related with cancer diagnosis (59).

Realizing that recommendations from healthcare providers have a significant impact on patient behaviour (60), health professionals must take into account that a breast cancer diagnosis may be an opportunity to promote changes in risk behaviours, namely the smoking cessation (41, 50) and, consequently, improve other health outcomes (41, 58).

3.2.2 Alcohol

The association between alcohol consumption and prognosis after breast cancer diagnosis has been inconsistent (61), due to some evidence that indicates that alcohol consumption has positive but also negative health effects (62). By one hand, prior studies suggest that moderate alcohol intake was not associated with the risk of recurrence (63, 64) and non-breast cancer mortality (64, 65), and is associated with a small reduction in breast cancer–specific mortality for women with ER-negative disease (61). Also, in the Women's Healthy Eating and Living (WHEL) study, moderate/heavy alcohol intake (>300g/month) was protective against all-cause mortality in a proportional hazards model adjusted for obesity (63). On the other hand, compared with non-drinkers, high levels of alcohol intake seems to increase breast cancer mortality and recurrence (with an intake of 6g/day) (66). The risk of recurrence due to drinking was greater in overweight women, but was not associated with all-cause death, suggesting a cardio-protective effect (66).

Additionally, after diagnosis, alcohol intake was not associated with disease-specific survival, compared with non-drinkers, and results did not vary by beverage type; those who consumed moderate levels of alcohol, either before or after diagnosis, experienced better cardiovascular and overall survival than non-drinkers (67).

According to the latest guidelines, the recommendations for alcohol use are to limit its intake to no more than two drinks per day for men and one drink per day for women, which is also suggested for cancer survivors (68). However, reports of excessive drinking

among cancer survivors (including breast) ranged from 4.7% to 41.0% (35-37, 54, 56), although different criteria for excessive drinking were used across studies.

Given the incongruent results regarding alcohol consumption, following a breast cancer diagnosis, further confirmation is needed in other prospective studies (64). In addition, healthcare providers must consider some factors when making recommendations, such as cancer type and stage of disease, treatment, treatment-related side effects (69), risk factors for recurrence or new primary cancers and comorbid conditions (62, 64).

3.2.3 Physical activity

Physical activity has been associated with several positive health-related effects among breast cancer survivors. In fact, data from a meta-analysis found that post-diagnosis physical activity decreased breast cancer deaths, all-causes mortality, disease recurrence and poorer breast cancer prognosis (70). Post-diagnosis physical activity also reduced the risk of mortality among women with BMI ≥25 kg/m^2 and reduced breast cancer deaths and all-causes mortality among patients with oestrogen receptor positive tumour (70).

Furthermore, physical activity has been shown to enhance quality of life among breast cancer survivors (71-73). Particularly, physical activity improves cardiovascular fitness, muscle strength, body composition, social functioning, self-esteem and physical, functional and emotional components of life's quality and has been associated with lower levels of fatigue, anxiety and depression in breast cancer survivors (71, 74). Likewise, physical activity is associated with improvements in other adverse effects of cancer, like lymphedema by ameliorating symptoms and its severity for those in whom the condition was pre-existing (75).

Taking into account recommendations from the World Cancer Research Fund for cancer prevention (76), general population and cancer survivors should be physically active for at least 30 minutes every day. However, only 20-30% of breast cancer survivors were active after they recover from treatments, and in USA it estimated that only 37% of breast cancer survivors are meeting American College of Sports Medicine guidelines for physical activity, that advocates that adults aged 18-64 years should practice at least 150 minutes per week of moderate intensity or 75 minutes per week of vigorous intensity aerobic physical activity or an equivalent combination of moderate and vigorous intensity

aerobic physical activity (62). The training sessions should be done in episodes of at least 10 minutes for session and spread throughout the week. Likewise, adults should perform muscle-strengthening activities involving all major muscle groups at least two days per week. Individuals aged 65 years or older should follow these recommendations as possible with their chronic conditions.

Accounting on these facts, regular physical activity is an effective intervention to improve quality of life in breast cancer patients and survivors (71), and together with a healthy diet, it promotes general health and well-being over the long-term (77) and decreases comorbid conditions, like cardiovascular disease and diabetes (78, 79).

3.2.4 Diet

Healthier dietary habits are a source of overall health and it is related to specific cancer outcomes (80). However, particularly for breast cancer, evidence from previous studies is mixed. During the past decade, the effect of diet after breast cancer has become relevant in research, focused on single macronutrients and specific nutrients (75), such as fat intake (76), and the study of overall diet quality (81). Recent evidence in diet evaluation takes into account the complexity of diet and the potentially synergistic or antagonistic effects of all individual dietary components (77). However, there are few studies that examine benefits for survival in association with overall dietary patterns (82).

The impact of diet after breast cancer diagnosis has been found in several studies. Overall, results suggests that women who consume better quality diet (high intakes of vegetables, fruits, vegetable oil, sauces/condiments, and soups/bouillons) have lower risk of death from any cause and lower risk of death from non-breast-cancer causes, compared with an unhealthy dietary pattern (high intakes of red meat, processed meat, and deep-frying fat) (83). Also, high-fat dairy intake was associated with different health-related outcomes: women who consumed larger amounts of high-fat dairy had higher breast cancer mortality (84), breast cancer recurrence (84) and higher non–breast cancer mortality (85); trans-fat intake was also linked with a 45% and 78% increased risk of all-cause mortality (86).

The consumption of five or more daily servings of fruit and vegetables is related with better survival (87) and lower risk of mortality (88), with a protective effect in recurrence (89, 90). Moreover, evidence suggests that a low-fat and high-fibre diet might be

protective against cancer recurrence and progression (91), as well, the omega-3 fat intake is linked with an inverse association with all-cause mortality (86). Likewise, in a study who examined the association between healthy eating practices and quality of life found that breast cancer survivors with healthy eating practices had better global quality of life, social, emotional, cognitive and role functions (92).

Dietary guidelines from World Cancer Research Fund recommend cancer survivors to consume at least 5 portions of fruit and vegetables each day (76). Studies assessing the prevalence of fruit and vegetables consumption found that only 18 to 47% of cancer survivors (including breast) are meeting recommendations (38, 39, 56, 57), even if after diagnosis the consumption tends to increase.

Some studies have been testing the effect of diet modification in breast cancer survivors and they have shown conflicting results (93, 94). The WHEL study tested the effect of a diet very high in vegetables, fruit, and fibre and low in fat on cancer outcomes in pre and postmenopausal breast cancer survivors (93). At 6 years, the intervention group had increased to an average of 9.2 servings per day, whereas the control group averaged 6.2 servings per day. Recurrence-free survival did not differ between the two study arms (93). Nevertheless, in the Women's Intervention Nutrition Study, that evaluated a low-fat diet in postmenopausal women with early-stage breast cancer (94), although on average the women in the intervention arm only decreased fat intake to 20% of energy at year one, after five years of follow-up, results showed that a diet low in fat demonstrated a significant decrease in breast cancer survival and new breast cancer events, compared with those in the control group (94).

In summary, diet is a potentially modified factor and health professionals should emphasize vegetables and fruits intake, parallel to regular physical activity and a healthy weight (62). Some trials demonstrate that a sustainable dietary modification, based on Mediterranean and macrobiotic dietary principles, can reduce body weight, metabolic syndrome and the bioavailability of sex hormones and growth factors (95). These results suggest that dietary changes should be recommended both for breast cancer prevention and treatment (95).

3.2.5 Body mass index

Many cancer survivors are overweight or obese at the time of diagnosis and it is known that overweight is associated with an increase in risk of developing many cancers (62), and also affects survival for postmenopausal women with breast cancer (15).
The impact of obesity after breast cancer diagnosis was found in several studies (96-105), mostly related to breast cancer mortality or recurrence, based on BMI, but not all studies had statistical significant results. Overall, evidence shows an increase in recurrence rate (106), although few studies also present rate ratios below one (107) and null results (97, 99). Specifically, findings on the effect of BMI among pre or post-menopausal obese women, showed a greater rate in mortality from breast cancer in obese women, compared to normal weight women (104, 108). Furthermore, despite of most studies assess mortality rates in obese women (BMI≥30 kg/m^2) with breast cancer, when very obese women are included, this group presents the highest mortality rate (108); however, other studies found similar results among obese and very obese women, both having higher mortality rates than normal weight women (109, 110).

According to the "The Nutrition and Physical Activity Guidelines for Cancer Survivors" from American Cancer Society and recommendations from the World Cancer Research Fund, individuals who are overweight or obese should be encouraged and supported in their efforts to reduce their weight (62, 76). Despite these recommendations, results from the After Breast Cancer Pooling Project showed a prevalence of overweight and obesity of 32.6% and 17.9%, respectively (111) and a considerable part of women modify body weight after diagnosis.

A review, which investigated the frequency, magnitude and pattern of weight gain among breast cancer survivors, revealed that 50–96% of women experience weight gain during treatment and women who maintains a stable weight during treatments also report growing weight gain in the months and years after diagnosis (112).The average weight gain ranged from 2.5-6.2kg, although higher gain was also common (113). Factors associated with weight gain were women receiving adjuvant chemotherapy (112, 114, 115), principally those with long-duration treatments and premenopausal women (112), higher disease stage, younger age, being postmenopausal, and those who decreased their physical activity from diagnosis to within 3 years after diagnosis (113).

Weight change after a breast cancer diagnosis has been associated with lower survival (98, 116) and increased breast cancer mortality (101, 117), cardiovascular disease

mortality and all-cause mortality (101). Weight change is also associated with health-related quality of life. In a cohort study with breast cancer survivors, compared to women with BMI <25 kg/m^2, women with BMI ≥30 kg/m^2 had increased arm symptoms, urinary incontinence, tendency to nap, and poorer physical functioning (118). Moreover, women with ≥5% weight gain had lower scores in physical functioning, role-physical and vitality, and participants with weight loss ≥5% had lower chest wall and arm symptom scores (118).

Overall, weight losses of 5% to 10% have significant health benefits, even if the ideal weight is not achieved (119). Among breast cancer survivors who are overweight or obese, the loss that comes from caloric restriction and intentional exercise enhances the quality of life and physical functioning. In addition, losing weight may reduce the risk of postmenopausal breast cancer (120, 121) and possibly other cancers (97, 122-124) in women without cancer.

Behavioural interventions can lead to weight loss in overweight and obese breast cancer survivors (125). This loss is beneficial to reduce the risk of recurrence among post-menopausal breast cancer survivors, especially those with oestrogen receptor ER negative tumours (126). On the other hand, it is known that weight management it is crucial for rehabilitation and recovery from treatments (obesity is related to increased operating and recovery times, higher infection rates, and poorer healing), to prevent comorbid conditions, such us cardiovascular disease and diabetes (127) and lymphedema (127, 128), fatigue, hot flashes (127, 129), functional decline and poorer health and overall quality of life (118, 127). Also, weight loss in the Exercise and Nutrition to Enhance Recovery and Good Health for You study lead survivors to improve their physical activity and blood pressure (125).

These findings are important to healthcare providers to enhance weight management, for instance through the promotion of healthy diet and physical activity, at all phases of the cancer care, in order to prevent sequelae and to improve general health (112, 127) and survival (101) and weight control strategies should be personalized to the medical history of survivors (116).

3.3 Factors associated with health behaviours and body mass index after breast cancer diagnosis

Changes in health behaviours and body mass index after a breast cancer diagnosis are influenced by a heterogeneous and complex variety of intrinsic and extrinsic factors. Nevertheless, the effect of each explanatory variable is inconsistent when specific health behaviour and anthropometric characteristics are analysed.

3.3.1 Socio-demographic characteristics

Regarding socio-demographic characteristics, older age has been associated with improvements in health behaviours among cancer survivors. In fact, when compared with younger patients, older adult cancer (including breast) survivors were significantly more likely to quit smoking (52); to improve their dietary behaviours, by decreasing their intake of fat and amount of takeaway food, and increase fibre and fruits/vegetables intake (130); to maintain their exercise levels after cancer diagnosis (52). However, other studies reported that older patients are frequently more physically inactive after treatments (33, 131, 132) and have less improvements in diet (132).

Subjects with higher education levels are also more likely to make positive changes in lifestyles (33), namely regarding dietary habits (33, 133) and physical activity (33, 131, 133, 134), although in another study they did not found changes in health behaviours depending on the education levels (130).

Employment status may be influenced by cancer diagnosis and treatment. A meta-analysis demonstrated that cancer survivors are 1.4 times more likely to be unemployed than healthy controls (135), and this risk was also identified for survivors of breast cancer (136). Those who returned to work were less likely to be young and out of active treatment (137), but evidence on the age effects on the return to work is conflicting (136-138). Yet, compared to young-adults, middle-aged adults are more often unemployed/homemaker or retired (139). Reasons on the basis of that are physical limitations, cancer-related symptoms, stage, time since diagnosis and socioeconomic factors (137-139). Furthermore, compared to middle-aged adults, young adults have higher functioning level at work, doing daily activities or pursuing own hobbies. In relation to lifestyles, a study of Humpel *et al.* (130) found that more employed individuals increased the intake of fibre compared to those not employed, while in another study no association was observed (132).

In addition, adult cancer survivors living in rural areas were significantly more likely to quit smoking after cancer diagnosis compared to those living in urban areas (52), and women who engaged in exercise practice were mostly married or living with a partner (140), although in other study there were no significant associations between physical activity and marital status (134).

3.3.2 Medical conditions

Clinical features may also influence the adoption of healthier lifestyles. For instance, it has been described that advanced stages of breast cancer are associated with lower interest in health issues (141) and diminished levels of physical activity (131, 134). Additionally, a review assessing cancer-related variables demonstrated that a higher stage of tumour, and more invasive or numerous treatment modalities, were related to greater improvement in diet, exercise, and smoking behaviour (132).

Time since diagnosis also plays a role in predicting health behaviours after diagnosis. Typically, the longer the time since diagnosis, the more positive the health behaviour changes (132). Cancer survivors who had completed treatment for more than one year are significantly more likely to make positive lifestyles changes (52, 133, 140), namely for maintaining their exercise levels after cancer diagnosis (52), although in another studies they did not find changes in health behaviours depending on the time since diagnosis (130, 134).

Patients who received radiation therapy report higher levels of physical activity, compared to those who receive chemotherapy or a combination of radiation and chemotherapy (134). Moreover, patients receiving three or more treatments are more likely to make dietary changes or start new physical activity, compared with patients receiving only one medical treatment (133). In addition, patients who quit smoking pre-surgery had better long-term abstinence rates than those who quit after surgery (140) and patients with comorbidities and being current smokers were more likely be physically inactive after treatments (131).

3.3.3 Psychological features

With regards to psychological features, patients with depressive symptoms reported lower levels of physical activity and those that were physically inactive were also more

likely to have lower adherence to dietary recommendations when compared to active patients (134). Additionally, other psychosocial characteristics, including social support and self-efficacy are predictors of fruit and vegetables intake (142).

In an inverse way, it has been hypothesized that distress, which includes anxiety and depression, may also be related with healthier behaviours, based on the notion that distress, especially fear, may give rise to motivation to change, making adaptive health behaviour changes, and may be a way of coping with distress (132). Pinto *et al.* found that higher baseline depression was related to subsequent increased vigorous exercise (143). Likewise, Maunsell *et al.* (32) observed that higher levels of depression were associated with more positive dietary changes in a sample of breast cancer patients in the first year after diagnosis; subsequent declines in levels of depression over the first year were also related to more positive dietary changes (132).

3.3.4 Health literacy

Health literacy has been a relevant and significant topic recognized globally, since it is considered a key factor in health promotion and it contributes to a healthier society (144). In fact, health literacy is associated with the ability to understand, interpret and analyse health information (such as diagnosis and treatments regimens) (144), the access to healthcare and preventive services, and possessing the ability to act on health information to improve overall health (145). Therefore, limited health literacy has been linked with poor health outcomes; for instance, people with limited health literacy are more likely to die from a chronic disease (144), such as cardiovascular disease (146), they have an increased risk of all-cause mortality (146), and they have poorer overall health (147), compared with those with higher health literacy levels. Moreover, the ones with limited health literacy have lack of ability to self-manage health effectively, access health services, understand available and relevant information and make informed health-related decisions and planning and adjusting lifestyle (148).

Limited health literacy is related with numerous modifiable risk factors for non-communicable diseases, including lack of physical activity, poor dietary habits, smoking and alcohol use (148). Results from European Health Literacy Survey which included health-related behaviours (smoking, alcohol, body mass index and physical exercise) showed associations, although different according to countries involved, but physical

activity was consistent and strongly associated with health literacy: the higher the health literacy, the higher the frequency of physical exercise (148).

Moreover, individuals with low health literacy were more likely to avoid physician visits, had lower knowledge about most common cancer screening tests and are less likely to look for health information from sources other than physicians (149).

4. Objectives

The growing number of breast cancer survivors worldwide, and their higher risk of comorbidities, highlights the relevance of studying multiple lifestyles risk factors, such as smoking status, alcohol consumption, physical activity, dietary patterns and BMI. Therefore, local specific data characterizing modifiable health behaviours within breast cancer survivors is crucial to implement lifestyles interventions in this population.

Thus, the main objective of this project is to analyse changes in health behaviours and BMI after breast cancer diagnosis, depicting the potential influence of socio-demographic characteristics, clinical and psychological features, and health literacy.

5. Manuscript

Changes in health behaviours and body mass index after breast cancer diagnosis: results from a prospective cohort study

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Abstract

Background: The adoption of healthier behaviours and body mass index (BMI) is essential to promote overall health among breast cancer survivors. The diagnosis of a cancer may contribute for its improvement among survivors.

Objectives: To analyse changes in health behaviours and BMI after breast cancer, depicting the potential influence of socio-demographic characteristics, clinical and psychological features, and health literacy.

Methods: We included 428 breast cancer patients prospectively followed for three years after diagnosis. Data regarding smoking, alcohol consumption, physical activity, fruit and/or vegetables intake, and BMI, either pre- or post-diagnosis, were collected at the end of follow-up. To quantify associations between patients' characteristics and changes in each outcome, adjusted odds ratio (AOR) and respective 95% confidence intervals (95% CI) were calculated using logistic regression.

Results: After diagnosis, 54.1% ceased the practice of physical activity, 32.4% became overweight/obese, and 6.1% reduced fruits and/vegetables intake to <5portions/day; there were virtually no changes towards alcohol consumption to >1unit/day or smoking. Among patients who did not meet recommendations before diagnosis, 29.1% stopped smoking, 24.6% diminished alcohol consumption to ≤1unit/day, and 3.3% had normal BMI. Older and more educated participants were more likely to cease physical activity (AOR=4.71, 95% CI: 1.17-18.99; AOR=11.53, 95% CI: 2.20-60.53, respectively). Older women had also lower odds to start this behaviour after diagnosis (AOR=0.32, 95% CI: 0.14-0.75).

Conclusions: Breast cancer patients showed some positive changes in their health behaviours after diagnosis; however, there is a large margin for improvement, which highlights the urgent demand for health promotion interventions in this context.

Keywords

Breast cancer; Cancer survivorship; Health behaviours; Body Mass Index.

Introduction

In the last few decades, the trends towards earlier diagnosis of breast cancer and use of more effective treatments have been contributed to an increased incidence and survival, and lower mortality rates (1-4). Consequently, in 2012, there were more than six million women with breast cancer alive at least five years after diagnosis (1), and it is expected that this prevalence continues to increase in the next years. Breast cancer survivors often experience late and long-term effects of disease and its treatments, including a higher risk of second primary cancers and other comorbidities, such as cardiovascular disease, osteoporosis, diabetes, sleep disturbances and depression (5-7).

The adoption of healthier behaviours, such as avoidance of smoking consumption, reduction of alcohol drinking, higher fruit and vegetables intake and physical activity, have been associated with decreased risk of cancer incidence (including breast cancer) (8, 9) and mortality (10-12), as well as increased survival of breast cancer (13-15), lower rates of recurrence (14, 16), and second primary cancers (17). These behaviours are also linked with lower prevalence of cancer and treatment-related symptoms (18, 19), and health-related quality of life after diagnosis (20, 21). Additionally, normal weight women also have decreased risk of breast cancer mortality (22) and recurrence (23), and other physical symptoms after breast cancer diagnosis, including increased arm symptoms, urinary incontinence, tendency to nap, and poorer physical functioning (24). This highlights the importance of health promotion efforts after a breast cancer diagnosis, taking advantage of the fact that women may be more motivated to improve their own health and to adopt a healthier lifestyle after this life event (25).

Local specific data characterizing modifiable health behaviours and anthropometric features among breast cancer survivors is essential to implement lifestyles interventions in particular settings. Therefore, we aim to analyse changes in health behaviours and body mass index after breast cancer diagnosis, depicting the potential influence of socio-demographic characteristics, cancer stage, anxiety and depression, and health literacy.

Methods

Study design and participants

The present analysis is based on a prospective cohort study of newly diagnosed breast cancer women. The study protocol has been previously described in detail elsewhere (26). Briefly, patients proposed for surgery were consecutively recruited in 2012, among those admitted to the Breast Clinic of the Portuguese Institute of Oncology of Porto, Portugal. Women that had received any treatment for breast cancer before, those previously treated with chemotherapy and/or radiotherapy in the chest and/or axillary areas for other primary cancers, and those considered less likely to be able to cooperate due to cognitive impairment [score lower than 17, or lower than 16 for women over 65 years, in the Montreal Cognitive Assessment (MoCA) (27, 28), were excluded. Overall, 506 patients with incident breast cancer were enrolled in this cohort.

Between January 2015 and January 2016, a three-year follow-up evaluation was conducted. Thirty one women were lost to follow-up: 11 patients died, 10 abandoned the study, six could not be contacted, two were transferred to another hospital and two were considered unable to cooperate by the neurologist. Therefore, a total of 475 (93.9%) completed this evaluation. Additionally, for the purposes of the present analysis, we also excluded women with cancer stage IV at baseline (n=3), patients with cancer recurrence (n=12) or a diagnosis of another cancer (n=32), remaining 428 breast cancer patients.

The study was approved by the Ethics Committee of Portuguese Institute of Oncology of Porto (Ref. CES 406/011 and CES 99/014) and by the Portuguese Data Protection Authority. All participants provided written informed consent.

Data collection

Data regarding health behaviours, either pre- or post-diagnosis, namely smoking status, alcohol consumption, physical activity (practice of sports or other physical activity), and fruit and/or vegetables intake (frequencies of consumption of fruits, vegetables side dish and soup) were collected through face-to-face interview at the three-year follow-up evaluation. Body weight at diagnosis and height was retrieved from the clinical records, and body weight three years after diagnosis was measured to the nearest 0.1kg using an analogical scale. Body mass index (BMI) was then calculated as weight (kilograms) divided by squared height (metres).

At the three-year follow-up evaluation, participants were questioned concerning educational level, marital and employment status, and income, before and three years after diagnosis.

Clinical records were reviewed for cancer stage at diagnosis, which was classified according to the American Joint Committee on Cancer staging manual (29).

To evaluate the presence of anxiety and depression at baseline, the Hospital Anxiety and Depression Scale (HADS) (30, 31) was applied. For each subscale, scores range from 0 to 21, and a score greater than or equal to 11 for each of them was considered a case of anxiety and/or depression, as applicable.

The evaluation of participants' health literacy was also performed three-years after the breast cancer diagnosis, using the Medical Term Recognition Test (METER), which was previously validated in the adult Portuguese population (32). This self-administered instrument consists in a list of 40 medical words and 30 made-up non-words that intuitively sound like real medical terms. The participants were asked to mark only the words they were sure to be actual words. Then, a score was calculated as the sum of all the correct words marked. Adequate health literacy was defined as scoring at least 35/40 in words and 18/30 in non-words.

To analyse proportions of participants meeting recommendations for cancer prevention, we adapted those established by the World Cancer Research Fund (8), assuming the following criteria: current non-smoking; alcohol consumption ≤1 unit per day; intake of at least five portions of fruit and/or vegetables per day; physically active (defined as practicing any sports or physical activity); normal weight (BMI <25kg/m^2).

Statistical analysis

Prevalence estimates and respective 95% confidence intervals (95% CI) were estimated for each health behaviour and BMI categories. To quantify the association between breast cancer patients' characteristics and changes in health behaviours and body mass index after diagnosis, adjusted odds ratios (AOR) and 95% CI were computed using unconditional logistic regression; this analysis was stratified according to the adherence to cancer prevention recommendations before diagnosis.

Statistical analysis was conducted using STATA®, version 11.2 (StataCorp, College Station, TX, USA).

Results

Overall, 50.7% of the women had less than 55 years of age at baseline, and 70.1% had less than 10 years of education. Just over half the breast cancer patients were employed and had income equal or lower than 500€, and nearly three-quarters of participants were married or living with a partner. A total of 55.6% of the women were diagnosed with less advanced cancers (stages 0/I). At baseline, 38.4% and 7.7% had anxiety and depression, respectively. At the three-year follow-up evaluation, nearly half of participants had inadequate health literacy (Table 1).

Concerning the prevalence of health behaviours and BMI (Table 2), 12.8% of the participants were current smokers previously diagnosis and 9.1% reported this behaviour after three years. The percentage of current drinkers diminished from 46.7% before diagnosis to 43.5% after diagnosis, and the proportion of women who referred a consumption of more than one drink per day pre- and post-diagnosis was 15.2% and 11.7%, respectively. Before diagnosis, nearly 70% of women had an intake of fruits and/or vegetables lower than five portions per day, while at the three-year follow-up evaluation this proportion was 65.6%. The great majority of participants did not do any physical activity before and after diagnosis (82.7% and 83.9%, respectively). The prevalence of overweight and obesity increased from 56.3% to 68.6%.

Figure 1 depicts the changes in health behaviours, according to the participants' levels of exposure before diagnosis. Among breast cancer patients who met the respective recommendations for cancer prevention prior to diagnosis, none started to smoke and only one woman increased her alcohol consumption to more than one unit per day (0.3%, 95% CI: 0.0-1.7). Among those eating at least five portions of fruits and/or vegetable per day, only 6.1% (95% CI: 3.0-11.8) reduced their intake to values below the recommendations. More than a half of women that reported physical activity before diagnosis, had ceased this behaviour (54.1%, 95% CI: 42.8-64.9), and nearly one-third of women with normal weight had become overweight or obese (32.4%, 95% CI: 26.1-39.5). Among breast cancer patients who did not meet the recommendations to each exposure before diagnosis, 29.1% quitted smoking after diagnosis (95% CI: 18.7-42.2) and 24.6% reduced alcohol consumption to values below the recommendations (95% CI: 15.7-36.4). A total of 9.9% of the participants become physically active (95% CI: 7.2-13.5) and 7.8% increased their fruits and/or vegetables intake to at least five portions per

day (95% CI: 5.2-11.5). Considering overweight or obese women before diagnosis, 3.3% presented normal weight three years after diagnosis (95% CI: 1.6-6.6).

With regards to the potential factors that may influence changes in health behaviours and BMI after a breast cancer diagnosis, women with older ages (AOR=4.71, 95% CI: 1.17-18.99) and higher education levels (AOR=11.53, 95% CI: 2.20-60.53) were significantly more likely to cease physical activity in the period post-diagnosis (Table 3). Among breast cancer patients who were physically inactivate before diagnosis, older women had significantly lower odds for starting this behaviour in the period post-diagnosis (AOR=0.32, 95% CI: 0.14-0.75). Compared with breast cancer patients with less advanced cancers, those with cancer stage II more frequently decreased their consumption of alcoholic beverages to less than one unit per day (AOR=4.36, 95% CI: 1.02-18.68) (Table 4).

Discussion

The present study has shown that, breast cancer patients often change their health behaviours and BMI after diagnosis, although these modifications differ by type of behaviour and adherence to cancer prevention recommendations before diagnosis. Globally, among patients who did not meet recommendations prior to diagnosis, there was a decrease in smoking and alcohol consumption and a slight increase in fruit and/or vegetables intake and physical activity. However, half of women that were physically active before breast cancer ceased this practice and one-third of those with normal weight were overweight or obese three years after diagnosis.

With regards to smoking consumption, we observed that almost 30% of smokers before diagnosis quitted smoking after breast cancer, which is similar with results found in another study (25). Interestingly, when compared to the Portuguese women from general population, the prevalence of current smokers after breast cancer diagnosis was lower (33). Therefore, we can assume that cancer survivors may be more receptive to change this behaviour after diagnosis, since not smoking is commonly recognized as the most important behaviour for cancer prevention (34), which may be a result of the greater attention that mass media gives to tobacco than other risk factors (35), as well as the impact of tobacco control policies (36) and their public discussion (37), in the awareness of the harmful effects of smoking.

Our results showed that, after diagnosis, almost one-quarter of breast cancer patients who are excessive drinkers before diagnosis decreased the consumption of alcoholic beverages, with 12% reporting consumptions higher than recommended three years after diagnosis. In prior studies, the prevalence of excessive alcohol consumption among breast cancer survivors ranged from 4.7% to 6.8% (38, 39). These differences may be due to different patterns of alcohol consumption across countries, as well as the use of distinct definitions and cut-off values among studies. Compared to other sample of women from general Portuguese population (40), after diagnosis, breast cancer patients were less likely to be current drinkers and excessive drinkers. These findings may reflect the effect of health promotion strategies; however, more noticeable improvements in alcohol consumption may be difficult to achieve, since moderate alcohol consumption is also advocated due to its protective effects on cardiovascular diseases and overall mortality (41).

Concerning fruits and vegetables intake, the prevalence of consumption lower than five portions per day after diagnosis observed in our study is similar to that observed in a previous study performed in the United States of America assessing breast cancer survivors (39); in reports from other countries, this prevalence is still high, varying from 50.0% to 81.8%, despite the fact that, as observed in our study, the consumption of fruits and vegetables tended to increase after diagnosis (21, 25, 38, 39). Moreover, prior investigations did not observed differences in fruits and vegetables intake between cancer survivors and non-cancer controls (38, 42-44). Lack of information can be a barrier; for instance, a previous study conducted in United States of America showed that in few healthcare providers ask or advise cancer survivors about dietary habits (45).

Three years after diagnosis, most participants have stopped their physical activity and, among those that were not physical active before diagnosis, few began this practice. Despite some studies reported higher levels of physical activity among cancer survivors (21, 25, 39), even when compared with general population (44), opposite results were also found (38, 46). The incongruent findings may be due to different instruments used to assess physical activity, distinct guidelines and characteristics of the samples. Additionally, compared with women from general Portuguese population (33), we found a higher prevalence of physical inactivity in breast cancer patients (70% versus 84%, respectively). In fact, lower levels of exercise in this population may be related with treatments' side effects (47), including fatigue, depression or anxiety (48).

The effect of cancer treatments, reduced physical functioning, increased fatigue, and weight gain are frequently associated with the higher levels of BMI previously observed in breast cancer survivors (49-51). Likewise, we also found an increase in BMI after diagnosis in those women that had normal weight pre-diagnosis, and three years post-diagnosis only one-third had levels of BMI as recommended, which is much lower than the observed in general Portuguese women (33). Since the problem of excessive weight is a result of multiple interactions between several factors, including lifestyles, the implementation of actions to promote overall health education may also contribute to maintain a healthy weight among this population.

In accordance to prior reports, we found that women with older age were more likely to report physical inactivity, particularly after treatments (52-54). Our work also revealed that more educated women were more likely to decrease their physical activity after diagnosis, which differs from the observed in previous studies (52, 54, 55). In addition, when compared with stages 0/I, women with more advanced stages more frequently

decreased their alcohol consumption after diagnosis to less than one unit per day. To the best of our knowledge, there are no data regarding the association between cancer stage and post-diagnosis alcohol consumption; however, in general, cancer survivors diagnosed with more advanced stages frequently make more positive changes in other health behaviours (e.g. smoking, diet), which may also be applied to alcohol consumption (53).

The present study was based in a prospective cohort study and we were able to follow for three years a large proportion of the patients enrolled. However, it has some limitations that need to be addressed. We excluded patients not submitted to surgical treatment and those with stage IV, recurrence or diagnosis of other cancer, which may limit the generalization to patients with more advanced disease. Likewise, all patients were selected from the same institution, the Portuguese Institute of Oncology of Porto. However, this is the largest hospital providing care to oncological patients in the north of Portugal, receiving patients from a wide geographical area, which may reduce this limitation.

Furthermore, information on health behaviours before breast cancer diagnosis was collected retrospectively, which may be hampered by recall bias. Since health behaviours were self-reported, desirability bias may also have occurred, which may contribute for an underestimation of smoking and alcohol consumption and overestimation of physical activity and fruit and vegetables intake. Furthermore, we were not able to measure the frequency, intensity and type of physical activity, and information regarding body weight before and after diagnosis was retrieved from different sources. METER was only applied at the three-year follow-up evaluation; although it may not reflect baseline levels of health literacy, since it may be improved by the higher contact with health systems after diagnosis, it may still allow the stratification of the sample according to broad categories of health literacy.

Likewise, it was not possible to verify how health behaviours and BMI changed in a non-cancer group from the general population, within this period of time. Nevertheless, due to the short period of follow-up, this fact may not have influenced our results. The possibility of observing other statistically significant associations between patients' characteristics and changes in health behaviours and BMI may have been hampered by the smaller sample size, and consequent reduced statistical power, inherent to the stratification of the analysis according to adherence of cancer prevention recommendation.

Our findings have shown that there is room to implement interventions specifically developed to promote healthier behaviours in this population, in order to create an opportunity for cancer survivors to maximize outcomes in survivorship, prevent chronic conditions and improve prognosis. Since most of cancer patients previously reported a marginal interest in seeking surveillance and health promotion information, even in the post-treatment phase (58), healthcare providers, particularly oncologists and primary care physicians, have a key role to promote health education and positively influence changes in health behaviours.

In conclusion, this study has shown that, although breast cancer patients performed some positive changes in their health behaviours, there is a large margin for improvement, which highlights the urgent demand for health promotion interventions in this context.

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Table 1. Socio-demographic characteristics, cancer stage, anxiety, depression and health literacy of breast cancer patients.

	N (%) n=428
Age at baseline (years)	
<55	217 (50.7)
≥55	211 (49.3)
Education before diagnosis (years)	
≤4	178 (41.6)
5-9	122 (28.5)
>9	128 (29.9)
Employment status before diagnosis	
Employed	224 (52.3)
Unemployed, retired or housewife	204 (47.7)
Income before diagnosis*	
≤500€	230 (54.9)
>500€	189 (45.1)
Marital status before diagnosis	
Married/cohabitation	313 (73.1)
Other	115 (26.9)
Cancer stage at baseline	
0/I	238 (55.6)
II	134 (31.3)
III	56 (13.1)
Anxiety at baseline	164 (38.4)
Depression at baseline†	33 (7.7)
Inadequate health literacy three years after diagnosis‡	197 (49.5)

* N=419 due to one missing value and eight participants that did not know/answer.
† N=427 due to missing values.
‡ N=398 due to missing values.

Table 2. Health behaviours and body mass index among breast cancer patients before and three years after diagnosis.

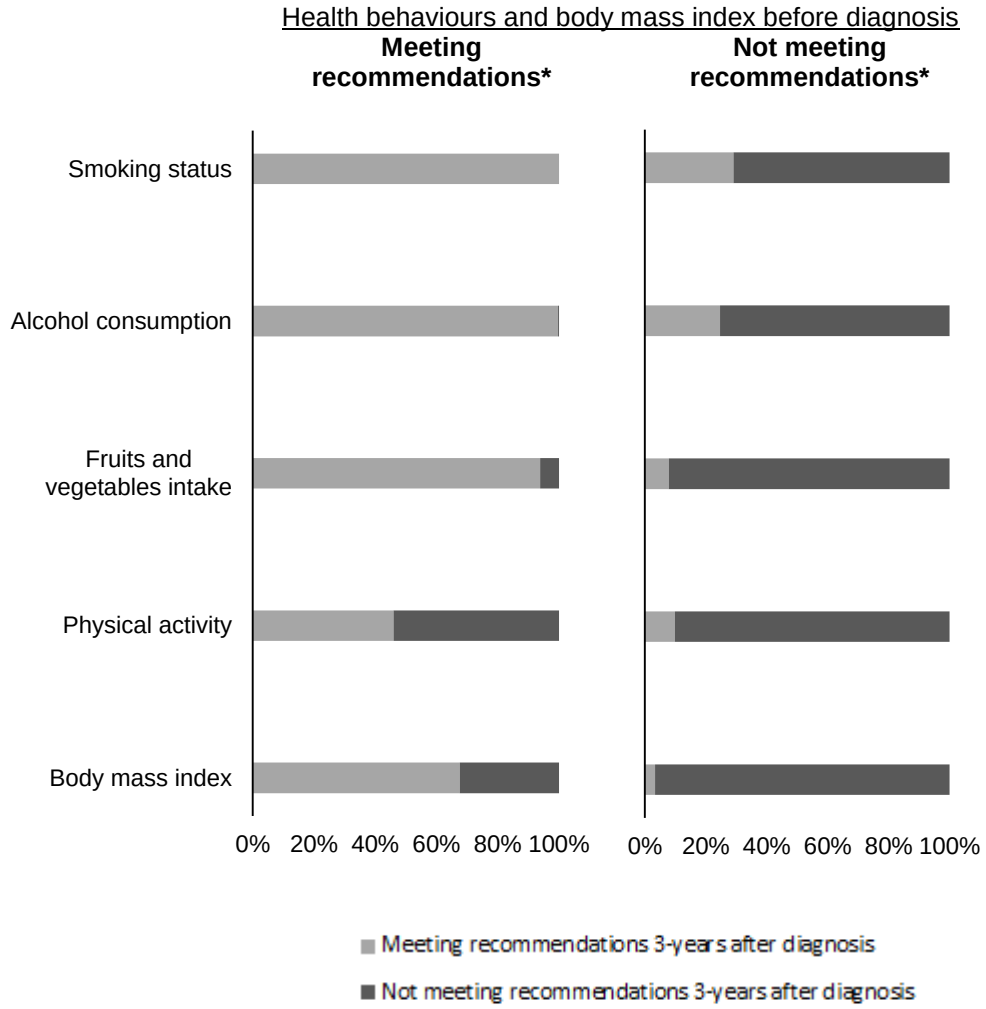
	Before diagnosis N (%)	**3-years after diagnosis** N (%)
Smoking status		
Never	337 (78.7)	337 (78.7)
Former smoker	36 (8.4)	52 (12.2)
Current smoker	55 (12.8)	39 (9.1)
Alcohol consumption		
Never	225 (52.6)	216 (50.5)
Former drinker	3 (0.7)	26 (6.1)
Current drinker	200 (46.7)	186 (43.5)
Current drinker >1 unit/day	65 (15.2)	50 (11.7)
Fruits and vegetables intake		
< 5 portions/day	294 (69.2)	279 (65.6)
≥ 5 portions/day	131 (30.8)	146 (34.4)
Physical activity		
No	354 (82.7)	359 (83.9)
Yes	74 (17.3)	69 (16.1)
Total number of unhealthy behaviours*		
≤1	133 (31.4)	163 (38.4)
2	221 (52.1)	206 (48.6)
≥3	70 (16.5)	55 (13.0)
BMI (kg/m^2)		
Normal weight	185 (43.6)	133 (31.4)
Overweight	143 (33.7)	179 (42.2)
Obesity	96 (22.6)	112 (26.4)

BMI, body mass index.

* Includes current smoking, alcohol consumption >1 unit per day, intake of <5 portions of fruit and/or vegetables per day and physical inactivity.

Note: In each variable, the total may not add to 428 because only participants with information concerning both moments were included in this analysis.

Figure 1. Changes in health behaviours and body mass index after diagnosis among breast cancer patients who did and did not meet recommendations for cancer prevention before diagnosis.



* Recommendations include current non-smoking, alcohol consumption ≤1 unit per day, intake of ≥5 portions of fruits and/or vegetables per day, physical activity, and body mass index <25.0kg/m^{2}.

Table 3. Association between participants' characteristics and adoption of unhealthy behaviours and overweight/obesity three years after diagnosis, among breast cancer patients who met recommendations before diagnosis.

	Health behaviours and body mass index three-years after diagnosis (only among breast cancer patients who met recommendations before diagnosis*,†)					
	Fruits and vegetables intake <5 portions/day		**Physical inactivity**		**Overweight/Obesity**	
	% (95% CI)	AOR (95% CI)‡	% (95% CI)	AOR (95% CI)‡	% (95% CI)	AOR (95% CI)‡
All	6.1 (3.0-11.8)	-----	54.1 (42.8-64.9)	-----	32.4 (26.1-39.5)	-----
Age at baseline (years)						
<55	3.2 (0.2-11.5)	1 [reference]	50.0(35.5-64.5)	1 [reference]	36.6 (28.3-45.8)	1 [reference]
≥55	8.8 (3.8-18.3)	4.14 (0.68-25.34)	59.4 (42.2-74.5)	4.71 (1.17-18.99)	26.0 (17.3-37.2)	0.56 (0.28-1.12)
Education before diagnosis (years)						
≤4	5.5 (1.3-15.4)	1 [reference]	33.3 (16.1-56.4)	1 [reference]	35.1 (24.0-48.1)	1 [reference]
5-9	5.9 (0.7-20.1)	1.39 (0.21-9.26)	50.0 (29.9-70.1)	5.00 (0.89-28.07)	34.5 (23.5-47.4)	0.69 (0.30-1.60)
>9	7.1 (1.8-19.7)	2.19 (0.38-12.74)	66.7 (50.3-79.9)	11.53 (2.20-60.53)	28.6 (19.3-40.1)	0.57 (0.25-1.28)
Employment status before diagnosis						
Employed	6.0 (1.9-14.8)	1 [reference]	57.1 (43.3-70.0)	1 [reference]	34.8 (26.7-43.9)	1 [reference]
Unemployed, retired or housewife	6.2 (2.0-15.4)	0.60 (0.11-3.31)	48.0 (30.0-66.5)	0.49 (0.11-2.07)	28.6 (19.3-40.1)	0.86 (0.39-1.88)
Income before diagnosis						
≤500€	8.6 (3.7-17.8)	1 [reference]	39.1 (22.1-59.3)	1 [reference]	27.7 (19.2-38.2)	1 [reference]
>500€	3.4 (0.3-12.4)	0.29 (0.04-1.89)	60.0 (46.2-72.4)	1.13 (0.25-5.14)	35.7 (26.9-45.6)	1.57 (0.76-3.23)
Marital status before diagnosis						
Married/cohabitation	4.9 (1.8-11.2)	1 [reference]	53.8 (40.5-66.7)	1 [reference]	33.8 (26.5-42.0)	1 [reference]
Other	10.3 (2.8-27.2)	1.79 (0.35-9.09)	54.5 (34.6-73.1)	1.16 (0.37-3.65)	28.3 (17.2-42.7)	0.82 (0.38-1.73)
Cancer stage at baseline						
0/I	5.5 (1.7-13.7)	1 [reference]	54.5 (40.1-68.3)	1 [reference]	29.1 (21.4-38.2)	1 [reference]
II	6.8 (1.7-18.9)	1.30 (0.27-6.34)	50.0 (30.7-69.3)	0.85 (0.28-2.59)	34.5 (23.3-47.8)	1.31 (0.64-2.67)
III	7.1 (0.0-33.5)	2.20 (0.20-24.65)	62.5 (30.4-86.5)	1.38 (0.25-7.61)	45.0 (25.8-65.8)	1.92 (0.69-5.32)
Anxiety at baseline						
No	4.9 (1.5-12.3)	1 [reference]	55.1 (41.3-68.2)	1 [reference]	28.0 (20.4-37.2)	1 [reference]
Yes	8.2 (2.7-19.7)	1.55 (0.35-6.78)	52.0 (33.5-70.0)	0.81 (028-2.36)	37.7 (27.7-48.8)	1.64 (0.86-3.11)
Depression at baseline						
No	5.1 (2.1-10.9)	1 [reference]	51.5 (39.7-63.2)	1 [reference]	32.4 (25.8-39.7)	1 [reference]
Yes	15.4 (3.1-43.5)	2.31 (0.34-15.76)	75.0 (40.1-93.7)	2.01 (0.33-12.32)	33.3 (15.0-58.5)	1.05 (0.33-3.32)
Health literacy three years after diagnosis						
Adequate	7.7 (2.9-17.2)	1 [reference]	62.0 (48.1-74.2)	1 [reference]	26.2 (18.6-35.5)	1 [reference]
Inadequate	3.8 (0.3-13.5)	0.54 (0.08-3.82)	40.0 (21.8-61.4)	0.69 (0.18-2.71)	43.8 (33.0-55.2)	2.02 (0.95-4.30)

AOR, adjusted odds ratio; CI, confidence interval.

* Recommendations include current non-smoking, consumption of ≤1 alcoholic beverage per day, intake of ≥5 portions of fruits and/or vegetables per day, physical activity, and body mass index <25.0kg/m^2.

† Smoking status and alcohol consumption were not included because none participant started to smoke after diagnosis and only one woman increased her alcohol consumption to >1unit per day.

‡ Adjusted for age, education and cancer stage.

Table 4. Association between participants' characteristics and adoption of healthy behaviours and normal weight three years after diagnosis, among breast cancer patients who did not meet recommendations before diagnosis.

	Health behaviours and body mass index three-years after diagnosis (only among breast cancer patients who did not met recommendations before diagnosis*)									
	Current non-smoking		Alcohol consumption ≤1 drink/day		Fruits and vegetables intake ≥5 portions/day		Physical activity		Normal weight	
	% (95% CI)	AOR (95% CI)†	% (95% CI)	AOR (95% CI)†	% (95% CI)	AOR (95% CI)†	% (95% CI)	AOR (95% CI)†	% (95% CI)	AOR (95% CI)†
All	29.1 (18.7-42.2)	-----	24.6 (15.7-36.4)	-----	7.8 (5.2-11.5)	-----	9.9 (7.2-13.5)	-----	3.3 (1.6-6.6)	-----
Age at baseline (years)										
<55	31.0 (19.0-46.1)	1 [reference]	18.2 (6.7-39.1)	1 [reference]	11.2 (7.0-17.3)	1 [reference]	14.9 (10.3-20.9)	1 [reference]	1.0 (0.0-5.8)	1 [reference]
≥55	23.1 (7.5-50.9)	0.69 (0.15-3.20)	27.9 (16.6-42.8)	-------	4.2 (1.8-9.2)	0.44 (0.15-1.29)	5.0 (2.5-9.4)	0.32 (0.14-0.75)	5.2 (0.2-10.5)	4.48 (0.45-44.35)
Education before diagnosis (years)										
≤4	20.0 (2.0-64.0)	1 [reference]	20.5 (10.5-35.8)	1 [reference]	4.9 (2.1-10.5)	1 [reference]	7.5 (4.2-12.8)	1 [reference]	5.1 (2.1-10.9)	1 [reference]
5-9	33.3 (17.0-54.8)	2.12 (0.18-24.77)	46.7 (24.8-69.9)	-------	9.2 (4.5-17.3)	1.27 (0.38-4.28)	7.8 (3.8-14.9)	0.65 (0.24-1.77)	-------	------
>9	27.6 (14.5-45.9)	1.57 (0.14-18.01)	9.1 (0.0-39.9)	0.54 (0.05-6.24)	10.6 (5.5-19.1)	1.42 (0.44-4.58)	16.3 (10.0-25.3)	1.54 (0.65-3.68)	3.4 (0.3-12.4)	1.18 (0.20-6.92)
Employment status before diagnosis										
Employed	27.5 (16.0-43.0)	1 [reference]	26.1 (12.3-46.8)	1 [reference]	9.0 (5.4-14.7)	1 [reference]	14.3 (9.8-20.3)	1 [reference]	1.9 (0.1-6.9)	1 [reference]
Unemployed, retired or housewife	33.3 (15.0-58.5)	1.85 (0.42-8.11)	23.8 (13.3-38.7)	0.98 (0.22-4.40)	6.5 (3.3-12.0)	1.35 (0.47-3.84)	5.6 (2.9-10.1)	0.61 (0.25-1.54)	4.6 (1.9-9.8)	1.26 (0.19-8.25)
Income before diagnosis										
≤500€	33.3 (16.1-56.4)	1 [reference]	20.0 (10.2-35.0)	1 [reference]	4.4 (2.0-8.9)	1 [reference]	6.8 (4.0-11.1)	1 [reference]	3.5 (1.3-8.1)	1 [reference]
>500€	24.2 (12.6-41.3)	0.46 (0.09-2.32)	32.0 (17.1-51.7)	3.12 (0.74-13.11)	10.9 (6.5-17.6)	2.34 (0.77-7.07)	13.7 (8.8-20.4)	1.62 (0.68-3.87)	2.2 (0.1-8.1)	1.49 (0.19-11.70)
Marital status before diagnosis										
Married/cohabitation	26.2 (15.2-41.2)	1 [reference]	22.0 (12.6-35.4)	1 [reference]	8.1 (5.1-12.7)	1 [reference]	8.8 (5.9-12.9)	1 [reference]	3.5 (1.4-7.6)	1 [reference]
Other	38.5 (17.6-64.6)	1.62 (0.42-6.29)	33.3 (15.0-58.5)	1.16 (0.23-5.90)	7.1 (3.0-14.8)	1.03 (0.38-2.82)	12.9 (7.4-21.4)	1.73 (0.79-3.80)	3.0 (0.2-10.9)	0.64 (0.12-3.55)
Cancer stage at baseline										
0/I	28.6 (15.1-47.2)	1 [reference]	17.6 (8.0-33.9)	1 [reference]	6.1 (3.2-11.1)	1 [reference]	8.8 (5.5-13.7)	1 [reference]	4.0 (1.5-9.3)	1 [reference]
II	27.8 (12.2-51.2)	0.81 (0.20-3.21)	33.3 (18.5-52.3)	4.36 (1.02-18.68)	13.5 (7.7-22.3)	1.92 (0.77-4.77)	10.7 (6.1-17.9)	1.10 (0.49-2.46)	2.6 (0.2-9.4)	0.92 (0.17-5.05)
III	33.3 (11.7-64.9)	1.10 (0.19-6.34)	25.0 (3.4-71.1)	2.92 (0.14-60.64)	2.4 (0.0-13.4)	0.32 (0.04-2.65)	12.5 (5.5-25.1)	1.35 (0.48-3.76)	2.8 (0.0-15.4)	1.01 (0.11-9.35)
Anxiety at baseline										
No	29.0 (15.9-46.7)	1 [reference]	18.4 (8.9-33.7)	1 [reference]	5.6 (2.9-10.1)	1 [reference]	9.3 (6.1-14.1)	1 [reference]	3.9 (1.6-8.4)	1 [reference]
Yes	29.2 (14.7-49.4)	0.94 (0.27-3.24)	33.3 (18.5-52.3)	3.80 (0.85-17.04)	11.4 (6.7-18.7)	2.10 (0.87-5.10)	10.8 (6.5-17.1)	1.21 (0.58-2.50)	2.4 (0.1-8.8)	0.61 (0.12-3.17)
Depression at baseline										
No	29.4 (18.6-43.1)	1 [reference]	23.0 (14.1-35.0)	1 [reference]	7.7 (5.0-11.5)	1 [reference]	10.3 (7.5-14.1)	1 [reference]	3.2 (1.4-6.5)	1 [reference]
Yes	25.0 (3.4-71.1)	0.76 (0.07-8.50)	50.0 (15.0-85.0)	3.57 (0.36-35.26)	10.0 (1.6-31.3)	1.21 (0.25-5.83)	4.0 (0.0-21.1)	0.42 (0.05-3.25)	5.9 (0.0-28.9)	2.23 (0.23-22.04)
Health literacy three years after diagnosis										
Adequate	29.3 (17.5-44.6)	1 [reference]	25.9 (12.9-44.9)	1 [reference]	7.4 (3.9-13.2)	1 [reference]	11.9 (7.6-18.1)	1 [reference]	2.0 (0.1-7.6)	1 [reference]
Inadequate	33.3 (13.6-61.2)	1.22 (0.21-7.13)	27.3 (14.9-44.4)	1.74 (0.36-8.39)	9.2 (5.3-15.1)	1.67 (0.62-4.54)	9.0 (5.6-14.3)	0.84 (0.37-1.90)	2.5 (0.5-7.3)	1.54 (0.19-12.23)

AOR, adjusted odds ratio; CI, confidence interval.

* Recommendations include current non-smoking, consumption of ≤1 alcoholic beverage per day, intake of ≥5 portions of fruits and/or vegetables per day, physical activity, and body mass index <25.0kg/m^2.

† Adjusted for age, education and cancer stage.

6. Conclusion

In conclusion, the present study have shown that, although breast cancer patients made some positive changes in health behaviours and BMI, women who met the recommendations for cancer prevention before diagnosis tended to maintain their smoking status, alcohol consumption and fruits and/or vegetables intake, and to cease physical activity and to increase BMI. Among the ones who did not met recommendations before diagnosis, only a few improved their behaviours and anthropometric characteristics.

These findings highlight the importance of outlining specific follow-up plans for the monitoring of these patients after treatments, with a particular focus on health behaviours and BMI, in order to reduce their risk of other comorbidities and to achieve a better overall health status.

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